Direct Observation of Momentum Conservation at the Au/Si Interface using BEEM

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The verification of parallel momentum conservation at a metal/semiconductor interface is a fundamental issue in interface transport. In epitaxial structures the question is less controversial, since atomically abrupt interfaces can be achieved between materials with matching lattice nets. Parallel moment um conservation in the case of a non-epit axial evaporated metal film is conceptually less straightforward. In addition, elastic scattering in the metal film can provide the necessary momentum for electrons to enter the semiconductor conduction-band, making evaluation of interface transport difficult,

Ballistic-electron-emission microscopy (BEEM) is a recently developed method for probing interfaces with nanometer resolution. One early prediction based on the idea of momentum conservation was the BEEM spectrum for Au/Si(111), which was expected to differ dramatically from that of Au/Si(100). The predicted behavior was not observed; instead, previously reported BEEM spectra are nearly identical to those for Au/Si(100).

In this talk, BEEM spectroscopy on Au/Si(111) structures as a function of Au thickness and temperature will be described. At 77K a direct signature of parallel momentum conservation at the Au/Si interface is observed in the BEEM spectra. The variation in spectral shape with both Au thickness and temperature places restrictions on allowable values of inelastic and elastic mean free paths in the metal, and also requires the presence of multiple electron passes within the Au layer. An independent indication of multiple reflections is directly observed in the attenuation of BEEM current with Au thickness.